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METROLOGICAL ARGUMENTATION OF THE ACCURACY AND DETERMINATION OF THE HANDICAP IN THE 4x100 M RELAY RACE

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Abstract: The large majority of specialists on sport domain, after the undertaken studies, proposed varied solutions to improve this process and promoted modern methods and means. In this way, came into being some installations, equipments and computerized technologies that more contributed to the improvement of the training process development [9]. The literature shows that running is a natural skill with great accessibility among pupils, regardless age and training level. Running is a natural movement, being the basis for all activities with dynamic content. Speed is a genetic motor ability being less perfectible, manifesting itself in various forms: reaction speed, speed of execution, recurrence speed, movement speed and speed in other arrangements of motor abilitys [6]. The study of this article highlights the metrological argumentation of accuracy and handicap determination in the 4x100 m relay race. There were identified the tasks according to the aim of the research: Determination of the optimal distance from the beginning of the 20m zone to the place where the relay is changed over; Determining the "handicap" length for runners with different forms of physical training; Determining the level of psychomotor qualities of athletes with different levels of sports training; Calculation of technique "handicap" accuracy based on athletes' reaction to a moving object. As a result of the analysis of the specialized literature, it was established that the problem of metrological argumentation of the accuracy and determination of the handicap in the 4x100 m relay running was treated quite differently by the vast majority of the studied authors.

Introduction: The authors believe that scientific research in sport, a sports training, shows that the process of achieving excellent sporting performance is closely linked to/closely linked to the most favourable/type of adaptive management of training is based on new concepts of principles that that derive from systems theory, cybernetics, information theory and, at the same time, from physiological and biological concepts biological activities. The 4 x 100 m relay

race is considered one of the most spectacular, but at the same time it is also the most technically difficult athletic event. One of the complexities of relay race is transmitting and receiving the baton at a full speed in a strictly regulated area. The results of the last Olympic Games in Beijing (XXVII) confirm the above, where the USA team, having in its composition the best sprinters on the planet and leaders in the final 4 x 100m relay race, with a range of 5 - 6 meters, had to stop the fight for the Olympic gold because of a serious mistake made at the moment of changing over the baton [3].

The main reason for what happened, in our opinion, is the premature start of the athlete's run, accepting the relay, even with a clearly calibrated handicap - the distance necessary to equalize the speeds of the athletes receiving and changing over the baton so that the relay is passed in a strictly regulated place - 2.5-3.0 meters before the end of the 30-meter changing over zone (changes in the rules were made after the XXX Olympic Games in Rio de Janeiro). Autorii consideră că "diferitele domenii în care se foloseşte tehnica măsurării pot fi încadrate parţial şi în sfera sistemelor de automatizare" [2].

Material-method: The research object – is the handicap in the 4x100 m relay race. Research subject - is the metrological argumentation of the accuracy and determination of the handicap in the 4x100 m relay run. Research hypothesis - it was assumed that the metrological argumentation of the accuracy will provide the possibility to determine the handicap in the 4x100 m relay run. Purpose of the research - is the investigative analysis and the metrological argumentation of the accuracy and determination of the handicap in the 4x100 m relay race.

There were identified the tasks according to the aim of the research: Determination of the optimal distance from the beginning of the 20m zone to the place where the relay is changed over; Determining the "handicap" length for runners with different forms of physical training; Determining the level of psychomotor qualities of athletes with different levels of sports training; Calculation of technique "handicap" accuracy based on athletes' reaction to a moving object. The experiment was carried out in the "Dinamo" athletics stadium, with 54 athletes, category III - I (women, men), in the period September - May, 2021, where we researched from the point of view the measurement's science both metrological argumentation of accuracy, and handicap determination in the 4x100 m relay race. It is necessary to know the overall condition of the athletes' body, especially biological parameters, for it gives us information on how the athlete behaves in training and competition Researches in the theory of sports training led impressive progress in recent years and the number of athletes capable of outstanding performance increased [12], iar autorul "the main psychomotor components that should be taken into account in addressing training are the following: body schema, laterality

and ambidexterity, spatial orientation, tempo and rhythm, external perception (visual, auditory, olfactory) and internal (kinaesthetic), visual visual differentiation, visual memory (reproduction gestures, images), auditory differentiation (sounds, different frequencies), auditory memory (reproduction of sounds associated with movement), attention and concentration, attention and concentration balance, ability to combine (couple) movements - specific coordination dynamics"[7].

Results and Discussions: In order our research to be carried out further, we have classified it into 4 aspects according to the proposed tasks, as follows: Determining the optimal distance from the beginning of the 20-meter zone to the place of changing over the baton. Athletes running in stages 2, 3 and 4 use the launch (10m) and change over (20m) area to receive the baton at full speed and complete their stage in motion. More over, the speed of the runners in the sprint relay stages should be maximum, and in the changing over areas it cannot be reduced. An indicator that characterizes the effectiveness of the technique of changing over and receiving in relay races can be the time required by a runner with a relay to pass by the change over zone of 30 meters. More over, the speed of the runners in the sprint relay stages should be maximum, and cannot be reduced in the relay areas. An indicator that characterizes the effectiveness of the technique can be the time in which the runner passes through the 20m relay changing over zone. For highly qualified male sprinters, this distance is covered in 3.0 sec or less, for women - in 3.3 sec or less [8,10]. Therefore, the runner right from the start has to use almost the entire 30m distance to gain the fastest possible speed. It is best if the speed of the runners at the moment of changing over the baton would be the same. The distance between the runners during the changing over the baton (1 - 1.3 m) is equal to the length of the runner's hand extended from behind, receiving the baton, and the length of the runner's hand extended forward, passing it on. The distance can be increased due to the tilt of the relay runner's torso [1,10] (Figure 1).

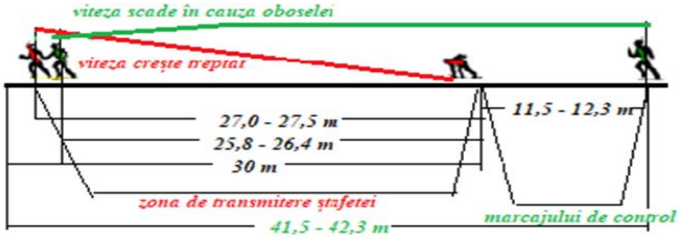

Fig. 1 The scheme for determining the control mark, for the start of the run of the one receiving the baton (Ozolin N.G., Voronkin V.I., 1979).

For the accuracy of the baton changing over, it is important to determine the moment of the start of the run of the person receiving the baton during training. To do this, a mark is made at a certain distance in front of the runway line. At the

given moment, the runner passing the baton reaches this landmark, the one receiving the baton quickly starts running along the right edge of his track, trying to develop as much speed as possible [1]. The distance to the mark must be such that the relay sprinter catches up with the relay receiver exactly at the place intended for transmission (4-5 m to the end of the zone). In the training process and based on the estimates, the marking is specified. Some experts [1,8,10,11] propose to determine this distance in such a way as to: first, clarify the place of relay change over (S = 25 m) and determine the running time for 25 m in the starting acceleration of the runner receiving the relay from the bottom starting position, support on one hand (for example, ti = 3.35 sec), as well as the last 25 m to the person changing over the baton over the distance of 75 - 100 m (tx = 2.25 sec).
Determining the "handicap" length for runners with different forms of physical training. Next, it is proposed to calculate the time difference between running the distance of 25 m when changing over and receiving - 1 (3.25 – 2.25 = 1.00 s), then calculate the average running speed of the transmitting athlete (25 m: 2.25 s = 11.11 m/s) and the time distance t (11.11m/s • 1.00 s = 11.11 m). This distance, according to the authors, will be the optimal value of the "handicap" of the technique for the athletes who change over and receive the baton [8,10] (Figure 1).

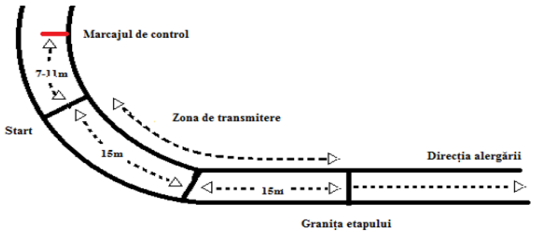

Fig. 2 Location (marking) of the main lines at the stages of the 4x100m relay race.

However, there is a very important detail here, which, in our opinion, plays a significant role in calculating the optimal duration of the technique's "handicap". It is certain that the participants in the 4 x 100 m relay run unequal segments: from 115 m for the first, and up to 130 m for the second and third, that is, the length of the running segment increases from 10 to 30%, which leads to a decrease in speed in the last 30 meters of the distance (Table 1). And in this context, they should already make certain adjustments to the methodology for determining the length of the technique handicap correction - taking into account the running time of the last 30 m, and not the 25 m, 100 m, but at the 130 - meter segment of the distance, because with the increase of the distance the running speed in the last meters will be lower [13]. The passing of the baton from hand to hand takes a certain time, and the athletes run side by side for a distance of up to (2 - 3 m), which must be taken into account.And this is already the reason for making certain adjustments to the methodology for determining the length of the "handicap" - to take into account the

running time of the last 30 m, and not the last 25 m, and not on the 100-meter, but on the 130-meter segment of the distance, because with the increase of the distance, the running speed on this last stage will inevitably decrease [13]. Passing the baton from hand to hand takes a certain time, and the athletes run a certain distance (from 2 to 3 meters) next to each other, which must be taken into account. [1,8] (Figure 2). Therefore, in our opinion, it is necessary to determine the distance from the control mark, not to the beginning of the relay transmission area, but to the place of its changing over (approximately at the 27th meter of the distance from the starting line of the athlete receiving the baton). In connection with the above, we believe it is possible to offer our own, somewhat different method for determining the technical handicap accuracy, which can be calculated using the following formula:

$$Sh = \frac{Tpr}{Ttr} \cdot 27.5 - 27.0$$

Fig. 4 Method for determining the technical handicap accuracy after formula

Where: Sh is the length of the "handicap", Tpr is the time for the receiver to complete the 30-meter segment from the start relay, Ttr is the time for the relay to cover the last 30 meters of the 130-meter distance.

Table 1. Calculation of the distance segment length (in meters) at different stages of the 4 x 100 meters relay race

Stages	**S_1 (m.)**	**S_2, S_3 (m.)**	**Sp (m.)**	**S_4 (m.)**	**S (m.)**	**Distance increase (%)**
1st stage	85		25-30		110-112	10-12
2nd stage		100	25-30		127-130	27-30
3rd stage		100	25-30		127-130	27-30
4th stage			25-30	115	115	15

Note: S1 is the length of the segment (in meters) from the start point to the running line of the relay receiver in the 2nd stage, S2, S3 is the length of the segment from the point starting (start) to the starting line of the run of the person receiving the baton in the 2nd and 3rd stage, Sp - the length of the segment from the starting line to the moment of passing the baton, S4 is the length of the segment from the start line of the run to the finish line on the 4th stage, S is the actual length of the stage.

In relay races where the running speed ratio of the receiving and passing runners is somewhat different, for example 4 x 200 m, 4 x 400 m, 400 + 300 + 200 + 100 m (small Swedish relay) or 800 + 400 + 200 + 100m (large Swedish relay), appropriate corrections must be made based on the fact that the change over is carried out with visual control [8,10]. Of course, the slower the runner completes the distance covered, the shorter the distance from the control mark to the beginning of the transmitter area should be. In relays where the running speed ratio

of the receiving and passing sprinters is somewhat different (4 x 200m, 4 x 400m, 400 + 300 + 200 + 100m or 800 + 400 + 200 + 100m), appropriate corrections should be made [8, 10]. A sportsman makes an impression not only by his psychomotor capacities, but also by his cleverness/brightness, this being the result of an exact and fast thinking [4].

Determining the level of psychomotor qualities of athletes with different levels of sports training. Taking into account the fact that the calculation process takes considerable time and creates certain inconveniences, we developed a special table (Table 2), which in a few seconds we can determine the "handicap" of the technique for several athletes participating in the relay running, sequentially from step by step [13]. Why do we only need to know the running time of the first and last 30m segments over the 130m distance.

Table 2. The handicap of the technique in relay running race

T_1" / T_2"	**2.90**	**3.00**	**3.10**	**3.20**	**3.30**	**3.40**	**3.50**	**3.60**	**3.70**	**3.80**	**3, 90**	**4.00**	**4.10**	**4.20**
2.50	4.90	6.00	7.10	8.20	9.30	10.40	11.5	12.6	13.7	14.8	15.9	17.00	18.10	19.20
2.60	3.67	4.73	5.69	6.85	7.90	8.96	10.02	11.08	12.13	13.19	14.25	15.31	16.37	17.42
2.70	2.54	3.56	4.50	5.59	6.61	7.63	8.65	9.67	10.69	11.70	12.72	13.74	14.76	15.78
2.80	1,48	2.46	3.39	4.43	5.41	6.39	7.38	8.36	9.34	10.32	11.30	12.29	13.27	14.06
2.90	0.50	1.45	2.36	3.34	4.29	5.24	6.19	7.14	8.09	9.03	9.98	10.93	11.88	12.83
3.00		0.50	1.40	2.33	3.25	4.17	5.08	6.00	6.92	7.83	8.75	9.67	10.58	11.50
3.10			0.50	1.39	2.27	3.16	4.05	4.94	5.82	6.71	7.60	8.48	9.37	10.26
3.20				0.50	1.36	2.22	3.08	3.94	4.80	5.66	6.52	7.38	8.23	9.09
3.30					0.50	1.33	2.17	3.00	3.83	4.67	5.50	6.33	7.17	8.00
3.40						0.50	1.31	2.12	2.93	3.74	4.54	5.35	6.16	6.97
3.50							0.50	1.29	2.07	2.86	3.64	4.43	5.21	6.00
3.60								0.50	1.26	2.03	2.79	3.56	4.32	5.08
3.70									0.50	1.24	1.99	2.73	3.47	4.22
3.80										0.50	1.22	1.95	2.67	3.39
3.90											0.50	1.21	1.91	2.62
4.00												0.50	1.19	1.88
4.10													0.50	1.17

Calculation of the "handicap" accuracy technique based on athletes' reaction to a moving object. At the same time, as practice shows, athletes who take over the relay begin to run with a slight delay, ie. not at the moment when the approaching athlete passes the control mark, but with a slight delay, which is due to individual characteristics - the so-called "reaction to a moving object" (RMO). As our studies have shown, this "delay" varies from 0.15 to 0.35 seconds. In this sense, the athlete giving the baton catches up with his partner to the set mark (Fig. 2), that is, the one receiving the baton does not have time to achieve the maximum possible speed on this distance segment. To eliminate this shortcoming, a slight adjustment should be made to the calculation of the "handicap" (Table 2). The total "handicap" value must also include a correction for the length of the segment covered by the

runner in this zone (due to the receiver's delayed RMO). To eliminate this shortcoming, a slight adjustment should be made to the calculation of the "handicap" of the technique (Table 3,5). The full value of the "handicap" of the technique must also include a correction (adjustment) for the length of the segment covered by the athlete passing the baton (due to the delay in the reaction to a moving object of the athlete receiving the baton). Tables 3 and 5 show the calculated data of these corrections depending on the training, temperament and psychomotor skills of the athletes. The tables we provide are simple and easy to use. When calculating, there were taking into account different combinations of time indicators for running distance control sections. It contains a large number of discrete values in a wide range with an accuracy of 0.05 m and is universal and applicable to men, women, and beginners as well as for high class masters.

Table 3. Calculation of the "handicap" of the technique according to time (T2) and running speed (Vм/c) when changing over the baton

			Corrections			
No. d/o	1	2	3	4	5	6
	T_2	Tsec Vm/sec	0.20	0.25	0.30	0.35
1	2.50	12.00	2.40	3.00	3.60	4.20
2	2.60	11.54	2.31	2.88	3.46	4.04
3	2.70	11.11	2.22	2.78	3.33	3.89
4	2.80	10.71	2.14	2.68	3.21	3.75
5	2.90	10.34	2.07	2.59	3.10	3.62
6	3.00	10.00	2.00	2.50	3.00	3.50
7	3.10	9, 68	1.94	2.42	2.90	3.39
8	3.20	9.38	1.88	2.34	2.81	3.28
9	3.30	9.09	1.82	2.27	2.73	3, 18
Σ	26.1	93.85	18.78	23.46	28.14	32.85
X	2.9	10.42	2.08	2.60	3.12	3.65

Table 4. Calculation of the Pearson statistical correlation (r) of the "handicap" technique of the baton change over in relation to all indicators

	T_2	Tc Vm/s	0.20	0.25	0.30	0.35
r	1	2	3	4	5	6
1		0.99	0.99	0.99	0.99	0.99
2			0.99	0.99	0.99	0.99
3				0.99	0.99	0.99
4					0.99	0.99
5						0.99

Table 5. Calculation of the "handicap" technique and the reaction to a moving object (tc) upon receiving the baton.

No. Corrections

d/o	1	2	3	4	5	6
	T_2	Tc Vm/s	0.20	0.25	0.30	0.35
1	3.40	8.82	1.76	2.21	2.65	3.09
2	3.50	8.57	1.71	2.14	2.57	3.00
3	3.60	8.33	1.67	2.88	2.50	2.92
4	3.70	8.11	1.62	2.78	2.43	2.84
5	3.80	7.89	1.58	1.97	2.37	2.76
6	3.90	7.69	1.54	1.92	2.31	2.69
7	4.00	7, 50	1.50	1.88	2.25	2.63
8	4.10	7.32	1.46	1.83	2.20	2.56
9	4.20	7.14	1.43	1.79	2.14	2, 50
Σ	34.2	71.34	14.27	19.42	21.42	24.99
X	3.8	7.93	1.58	2.15	2.38	2.77

Table 6 Calculation of the Pearson statistical correlation (r) of the "handicap" technique when receiving the baton in relation to all indicators

r	T_2 1	Tsec Vm/sec 2	0.20 3	0.25 4	0.30 5	0.35 6
1		0, 99	0.99	0.61	0.99	0.99
2			0.99	0.59	0.99	0.99
3				0.60	0.99	0.99
4					0.59	0.59
5						0.99

Note: Properties of the Pearson coefficient. 1. the perfect association between two variables leads to a correlation coefficient equal to +1 or –1; 2. associations of intermediate intensity lead to obtaining r's between 0 and 1, respectively 0 and -1. In table 4, 6 data are presented that highlight different degrees of association.

Tables 3, 4, 5 and 6 show the calculated data of these corrections depending on the preparation, temperament and psychomotor qualities of the athletes. The tables we provide are simple and easy to use. Since different combinations of time indicators for running distance control sections are taken into account in the calculations, it contains a large number of discrete values in a wide range, with an accuracy of 0.05 m, and is universal and applicable to men, women, both for beginners and for highly skilled masters. The algorithm for determining the "handicap" technique and using the tables is as follows: From the top start position with support on one hand (for runners, the 1st stage is from the bottom start), in turn, the athletes run a distance of 130 meters with time recording for the first and last 30 meters of the distance (for runners, 1st stage - only the last 30 meters of the 115meter distance).

Depending on the stage arrangement of the athletes, the indicators of the athlete changing over the baton (on the vertical scale) and the athlete receiving the baton (on the horizontal scale) are compared. At the intersection of two values, we mark the length of the "handicap" technique. If necessary, we make a correction (adjustment) in accordance with the data presented in Table 2.

The algorithm for determining the "reaction to a moving object" (ROM): The runner changing over the baton is located 25-30 meters from the control mark, and the runner receiving the baton is located 10-12 meters after the line of the control mark and takes the starting position from the bottom, supporting on one hand. The relay runner starts from the start and tries to get the maximum speed to the control mark, while two scouts start the timers when the relay runner crosses the line located 5-7 meters from the marker of control and stop the timers at different fixed times, the first - at the moment of passing the control mark by the one passing the baton, and the second - at the first movement of the one receiving the baton at the start moment. The difference between the indices of the two timers will also be the reaction of the one who receives the baton to the moving object (to the approaching runner who change over the baton).

Conclusions

1. As a result of the analysis of the specialized literature, it was established that the problem of metrological argumentation of the accuracy and determination of the handicap in the 4x100 m relay running was treated quite differently by the vast majority of the studied authors, iar "The moral qualities of sprinters, guards and jumpers are those of speed and detent, and in mixed-effort events it is necessary to train speed in endurance mode" [2]. In this sense, it was not specifically specified in the studied literature, how the "handicap" technique for the athletes who change over and receive the baton in relation to the time and speed in the running areas, „when designing a training program must be
based on an assessment of the somatic-functional abilities that the athlete has [5].

2. In order to carry out the scientific research presented in this experiment, a model of tables was developed, the content of which included the calculation of the "handicap" technique when transmitting and changing over the baton.

3. The increase in the value of the manifestation indices is due to the introduction of the "handicap" technique capping method in the 4x100m relay race (Table 2).

4. The results obtained as a result of the research, in which the implementation of the proposed model was foreseen, demonstrated an indisputable efficiency regarding the results obtained in our research.

5. The correlation analysis demonstrated the close connection (r = 0.99) between the calculation of the statistical correlation of the "handicap" of the

athlete's technique that pass the baton in relation to all indicators, which denotes the significant importance of the methodology proposed by us for this parameter.

6. And, when calculating the statistical correlation of the "handicap" technique of the athlete receiving the baton, the vast majority of indices demonstrated significance (r =0.99), apart from the indices of the statistical correlation calculation (r =0.60): T2 relative to correction time 0.25sec, Tsec/Vm/sec relative to correction time 0.25sec, The time 0.20sec in relation to the correction time 0.25sec. The time 0.25sec in relation to the correction time 0.30sec, which denotes the fact that in the area of the respective correlation parameters, more attention must be paid to the rigorous standards of application of the method proposed by us.

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